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In re application of: Theodore L. Wolf et al.	Examiner: Flemming Saether
Serial No. 10/090,283	Art Unit: 3679
Filed: March 4, 2002	Conf. No. 6591
For: **METHOD AND STRUCTURE FOR LOCKING NUT WITH DEFORMABLE MEMBER**	

Attorney Docket No. DYC-10-5598

DECLARATION OF THEODORE L. WOLF UNDER 37 C.F.R. § 1.132

I, Theodore L. Wolf, declare as follows:

1. I am one of the inventors in the above-entitled application.

2. I studied mechanical engineering at Fenn College (now Cleveland State University) from 1957 through 1961. I began working at Joseph Dyson & Sons, Inc. in the engineering department through a college cooperative study program in 1958, and remained with the company until its sale to another party in 1990. In 1992, as a principal, I purchased the assets of the former Joseph Dyson & Son, Inc. and started The Dyson Corporation. I have over 46 years of experience in the manufacture and sale of fastening products and, in particular, of large metal lock nuts for high stress and large structural applications.

3. I have reviewed the Heighberger (US Pat. No. 3,938,571), Wesley (US Pat. No. 2,378,610) and Hollinger (US Pat. No. 3,316,952) patents.

4. Based on my studies, experience and knowledge of the fastener industry, the lock nut structures disclosed in the Heighberger, Wesley and Hollinger patents are not structurally equivalent to the lock nut structures as claimed in the present patent application.

5. According to my experience and the study of my competitors over the last 48 years, all of the other large lock nuts and locking insert-engaging structures in the marketplace, including those taught by the Hollinger and Heighberger patents, are formed through machining standard nuts, not through forging feed stock. In fact, Dyson and Sons, Inc. is the original assignee of the Heighberger patent, and I have extensive experience in producing lock nuts according to its teachings. In the machining process, an insert carrying aperture is cut out of the nut body, thereby reducing original thread body length; and then a knurling bit is applied to inner aperture walls to cut more material away to form the insert-engaging teeth on the aperture walls. This process is cost-efficient in that a wide variety of different nut body shapes and sizes may be utilized with the same cutting tools, allowing a wide variety of finished product sizing to be generated. Typical start-up tooling and production costs for such an operation might require only from twenty to forty thousand dollars. Moreover, since standard nuts are used, a wide variety of third party nut products are readily available for selection and material supply.

6. However, forming the aperture and insert-engaging teeth structures through machining and knurling has significant disadvantages and limitations. For example, the dimensions of the knurled teeth are limited by the application characteristics of the machining tool, the knurling bit must fit within the void, and then must be small enough to rotate within the void as it rolls along the void wall, thus limiting the size of the cutting elements on the knurling and the responsively formed teeth. The size of the teeth are thus directly limited by the tolerances possible for maneuvering the knurling bit within the formed aperture, and smaller lock nuts will have a smaller maximum insert-engaging tooth size than those of larger nuts. Smaller teeth are not large enough to hold onto a locking insert throughout application or removal, causing large application costs and inefficiencies. As a result, the prior art lock nut is rendered inappropriate for some applications.

7. The dimensions of machined insert-engaging teeth are also limited by the hardness of the nut body material as the nut body material hardness increases the amount of material that may be cut away through a knurling process correspondingly decreases. Thus, harder nut bodies necessarily have smaller machined insert-engaging teeth, further increasing application costs and inefficiencies.

8. Another critical disadvantage of machined lock nuts is the loss of thread length in creating an insert-engaging aperture. Generally a reduction in thread engagement length results in a correspondingly greater reduction in performance strength of a nut, whereas the relationship of reduction in performance strength to reduction in thread engagement length has logarithmic characteristics. Strip tests on Heighberger nuts reveal dramatic strength reductions when thread body length is cut away to form the insert-engaging apertures, resulting in a higher rate of nut thread failure. Thus the standard prior art lock may not meet required strength tolerances for some structural applications, wherein a standard nut of the same hardness with the complete and undiminished thread length does.

9. In order to overcome the above disadvantages, my company sought an improved lock nut with improved strength and insert-engaging characteristics which would enable the use of lock nuts in applications unavailable to the prior art lock nuts. Our research resulted in the present invention - a forged lock nut with a plurality of large well-formed and structurally improved insert engaging teeth and a thread body length equivalent to that of a standard nut.

10. The use of a forging process was not an obvious choice. Forming the lock nut through forging is extremely costly in comparison to the prior art machining methods. Rather than twenty to forty thousand dollars, a forging process appropriate for the present invention requires about 1.5 million dollars. Moreover, although the examiner cites to Wesley as a forging reference, Wesley does <u>not</u> teach "forging" as it is understood in the fastener industry: he teaches ***stamping processes*** involving sheet metal stock, and on a much smaller scale. The stamped nuts taught by Wesley are too small for large (two inch and above) fastener applications, and he <u>cannot</u> form the large high tensile fasteners of our

invention by stamping them out of sheet metal: sheet metal will not provide the same high strength, and possible size is limited by the stamping process: structurally robust metals such as the ASTM medium carbon steel have lower ductility and flowing properties and are not generally amenable to forming nuts through stamping processes. The only example Wesley provides has an insert aperture with a 17/64 inch diameter and a 3/32 inch height, the nut bore diameter of 5/32 inch and the entire "nut blank" having a height under 5/16 inch. (As described in his specification at the fourth column, lines 11 through 41.) Wesley's lock nuts are small, lightweight nuts for aircraft applications, produced by stamping sheet metal stock (see the third column, lines 17 to 33), and even then he limits the number of his insert-engaging "projections" to "eight" due to the necessity of avoiding "tool breakage" in engaging the metal blank material and forming the projections. (See his figures and the second column, lines 29-43, and fourth column, lines 11 through 41.) Additionally, it has been my experience that the limited number of projections taught by Wesley does not sufficiently engage a locking insert during application and removal. But most importantly, the Wesley sheet metal stamping processes do **not** produce the higher tensile lock nut structures with increased spline and wall material density and homogenous grain contour lines formed through forging equivalent to our invention, and Wesley offers no guidance in forming them.

11. What is new and unexpected is that longer thread body length enables the use of a more ductile and flowable steel feed stock in the forging process, such as an ASTM standard medium carbon steel, which may then be subsequently hardened. With the longer thread body, our invention may now be used in applications denied to prior art lock nuts made from the same body material but having diminished thread body length. Large nuts of two inches and above with a high pitch count and highly defined shape of the present invention's insert-engaging splines may now be formed through forging without the tool breakage issues present in Wesley. Moreover, forming the splines and actuating wall through the forging process results in material being compressed into the desired shape by a stamping action, resulting in an increased material density compared to machined splines and walls, and compared to the remaining forged body metal, wherein the tips of the stamped splines have hardness greater than that of the core body.

12. Another advantage is that our forged splines are not limited by the above machining limitations, and are thus larger than machined teeth in smaller lock nuts, which enables sharper elements and elements that can penetrate farther into deforming locking inserts, providing correspondingly greater retention of the insert in the lock nut during removal and application.

13. Another disadvantage of machining of insert-engaging teeth is that by cutting the metal, the grain-flow structure of the metal is disrupted. As is well known in the metallurgical arts, metal bodies are preferably formed with long contiguous grain line structures, wherein individual molecular "grains" are joined together to define contour lines. Metal objects formed about unbroken continuous grain contour lines have much stronger structural integrity compared to those formed from an amalgamation of broken and fractional contour lines. More specifically, when a metal objects is machined, the grains are cut, resulting in short, broken grain lines. In contrast, the splines and walls forged by our invention have much greater strength, as in forging the grain contour lines remain unbroken and will generally assume the contour of the formed body. The grains not only remain unbroken, but form a tough, fibrous structure conforming to the outline of the part.

14. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §101, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 4/7/04 Theodore L. Wolf

Theodore L. Wolf